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Safety Awareness for responders to Emergency Operations: Fall Protection for Roofing

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Overview

- Introduction to Falls
- Types of Fall Protection
- Low Sloped Roofs
- Steep Slope Roofs
- Applying the OSHA Standards

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Objectives of this training - At the end of this short session, you should be able to:

- Have a better understanding of the potential fall hazards you face as a roofer.
- Be able to recognize a fall situation.
- Understand the means and methods available to eliminate or protect you from the fall hazard.
- Understand the contents of OSHA Subpart M.

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Fall Facts

- **The *leading cause of fatalities* and a leading cause of injuries in construction.**
  - **100,000 injured**
  - **150 - 200 deaths**
  - **35% of Construction Fatalities (2001)**
  - **84% of injured lose time from work**
  - **33% of injured are hospitalized**

$2 billion cost to employers each year.

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What Causes Falls?

- **91% - no fall protection worn**
- **82% - no fall protection in place**
- **79% - wore harness or belt but not attached**
- **75% - loss of footing, balance, or grip**

Falls are the leading cause of on-the-job deaths in construction. Sixty percent (60%)of all falls were preventable by fall protection.

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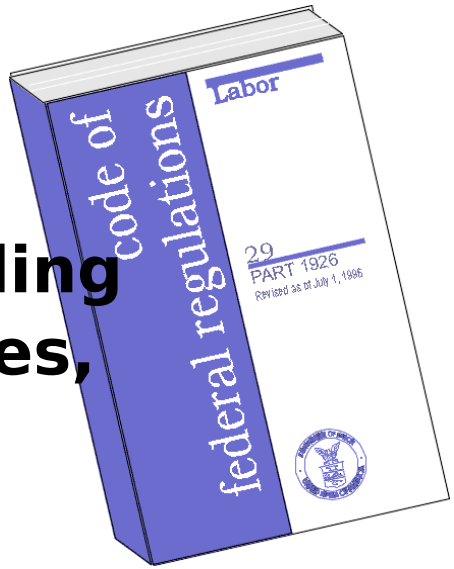
Fall Protection Required

- **Most work *6 feet* above levels to which you could fall:**
  - **Ramps, runways, walkways, excavations, hoist areas, holes, formwork, reinforcing steel, leading edges, unprotected sides or edges, overhand bricklaying, roofing, pre-cast concrete erection, wall openings, residential construction, and other walking/working surfaces.**



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Fall Protection Required 2

- **Does not cover workers assessing workplace conditions prior to start of project or after work is completed.**
- **Does not cover scaffolds, steel erection, or crane-supported platforms.**

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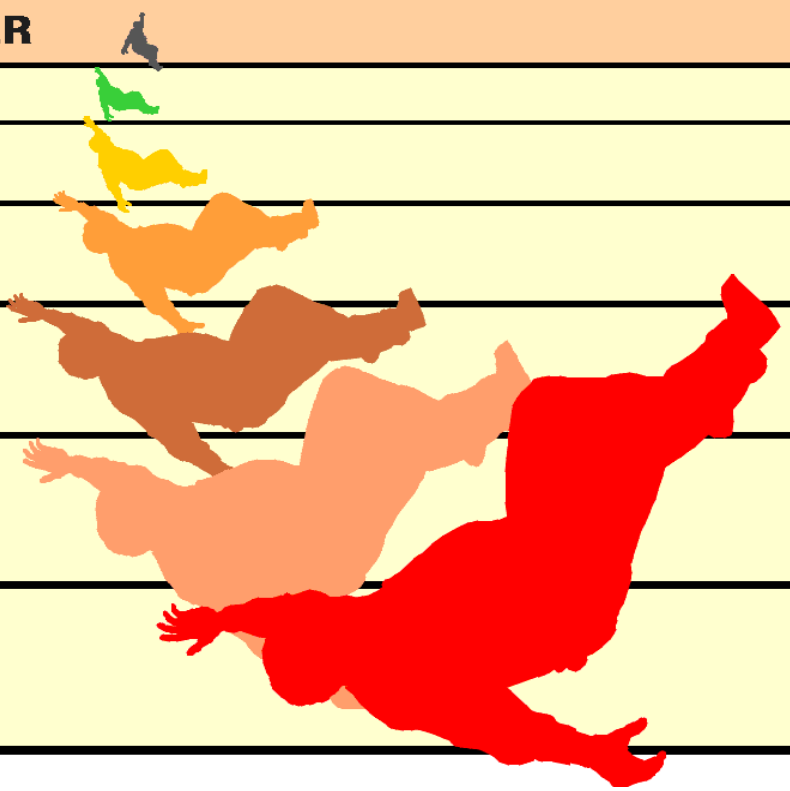
The Six Foot Fall

200 lb. Worker falling 6 feet = 9,000+ lbs. of energy

FALL DISTANCE	TIME (SEC)	IMPACT FORCE 200 lb WORKER
2.0 inches	0.1	256 lbs
7.6 inches	0.2	1,024 lbs
17.0 inches	0.3	2,304 lbs
31.0 inches	0.4	4,096 lbs
48.0 inches	0.5	6,400 lbs
69.0 inches	0.6	9,216 lbs



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Fall Protection

- **Two basic approaches:**
  - **Fall Prevention - keeps workers, tools, or materials from falling off, onto, or through working levels.**
  - **Fall Arrest - catches workers, tools, or materials after they have fallen, before they strike a lower level.**

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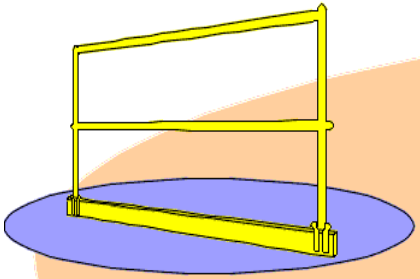
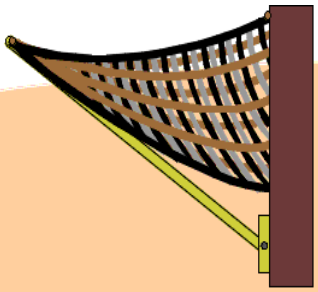
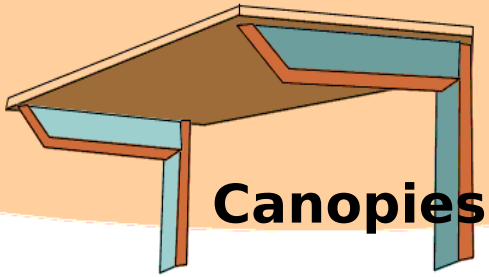
Subpart M Options for Protection



Guardrail Systems

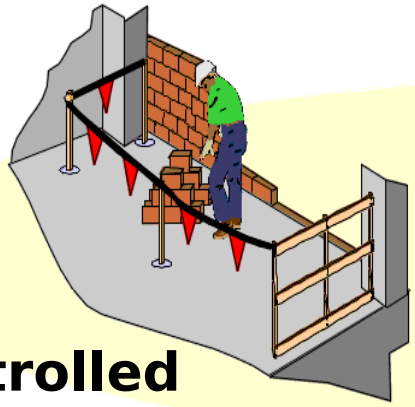


Hole Covers



Canopies

Personal Fall Arrest Systems



Controlled Access Zones

Warning Line Systems

Safety Monitoring Systems

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Guardrail Systems

- **A barrier between you and the fall.**
- **This is a method of fall prevention.**
- **Guardrails are *passive fall protection***
  - **You are protected without doing anything.**

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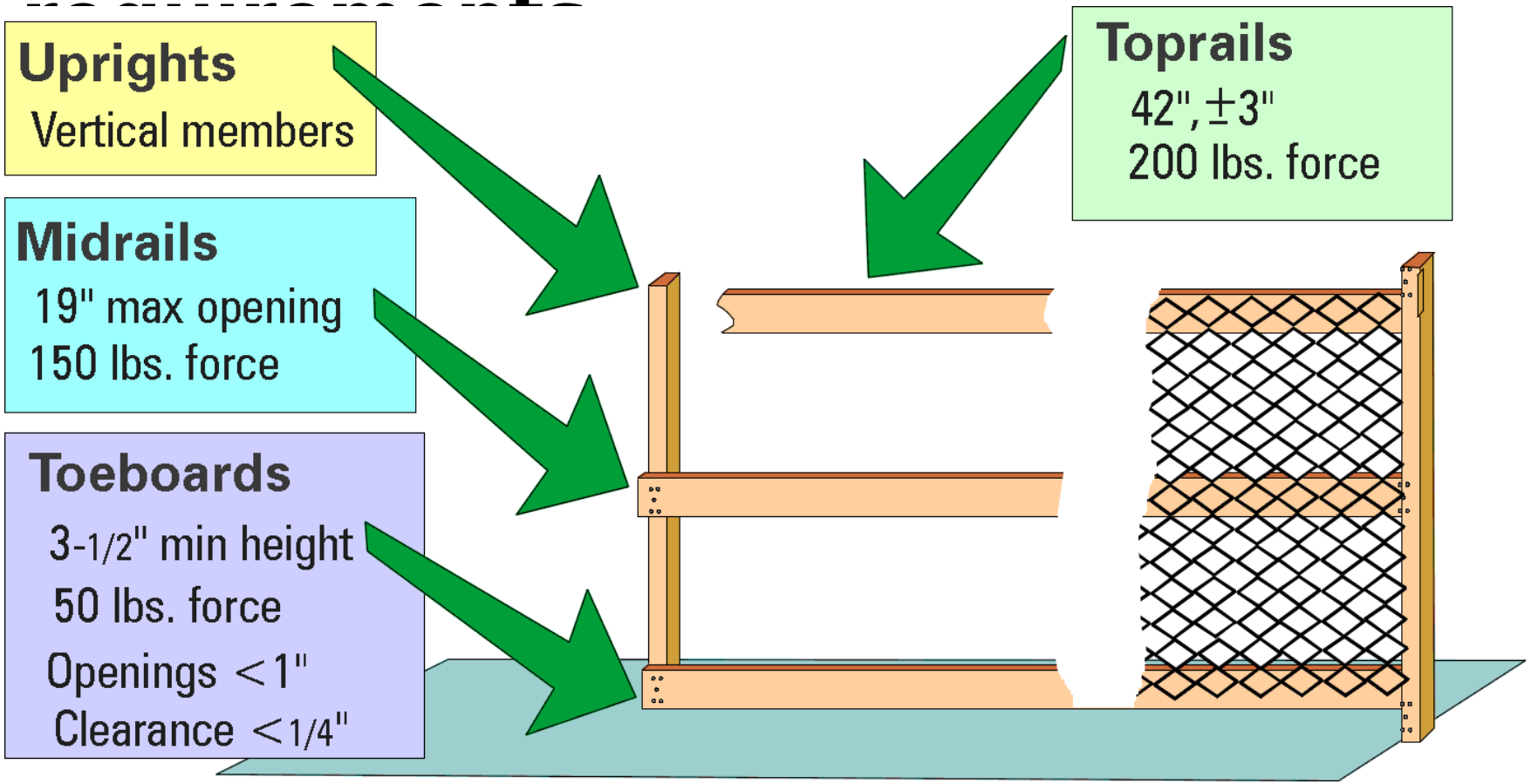
Guardrail Requirements

- **Subpart M presents basic requirements**



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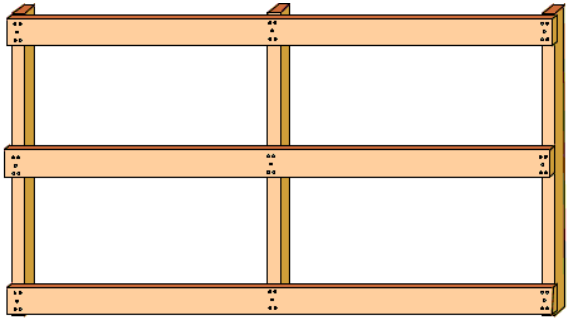
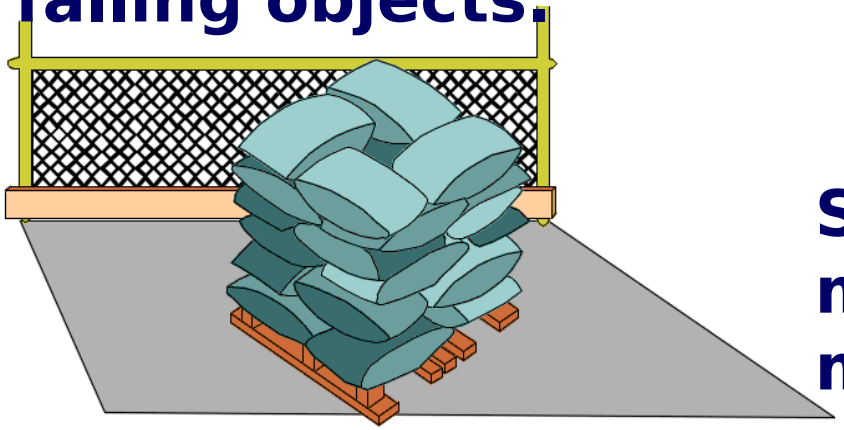
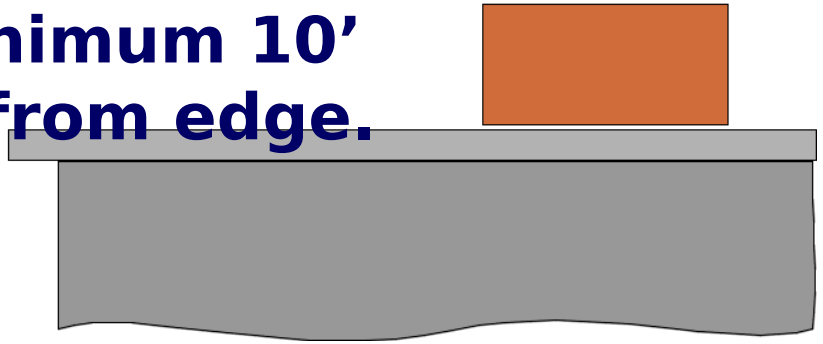
Toeboards

Toeboards prevent tools or materials from becoming falling objects.





Store materials minimum 10’ from edge.



Add screen or mesh if tools or materials extend above toeboards.

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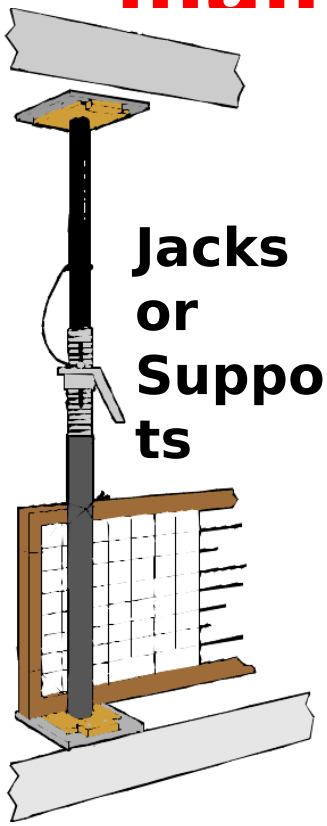
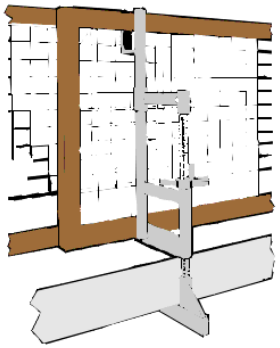
Guardrails Installed

- **Guardrails must be functional & maintained**

Nails, Screws, or Bolts

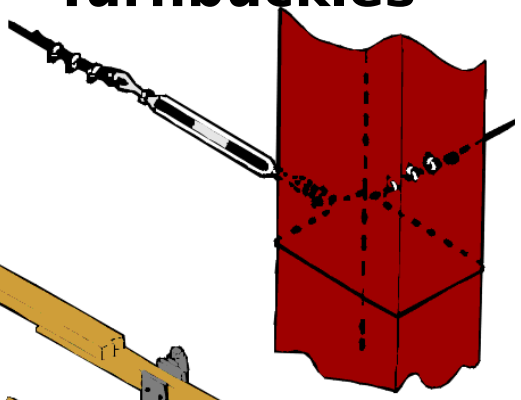


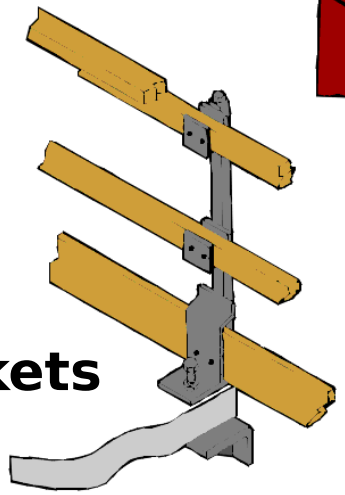
Jacks or Supports



Clamps

Turnbuckles





Brackets

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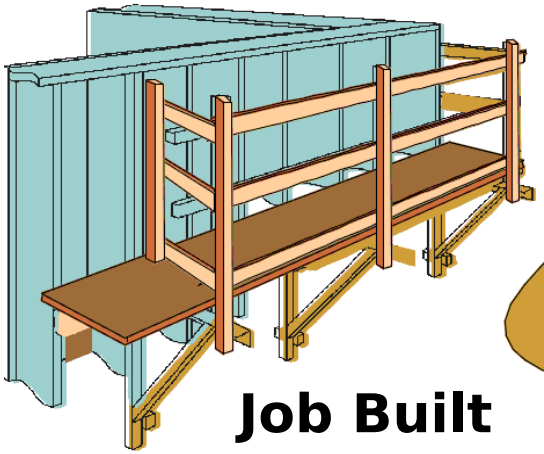
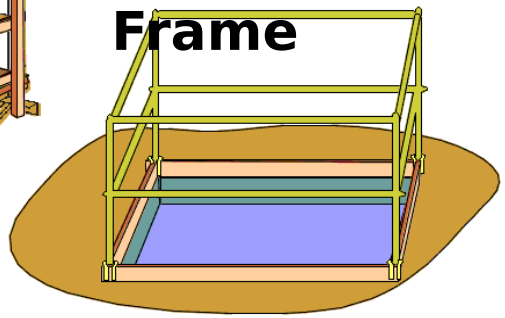
Guardrail Types

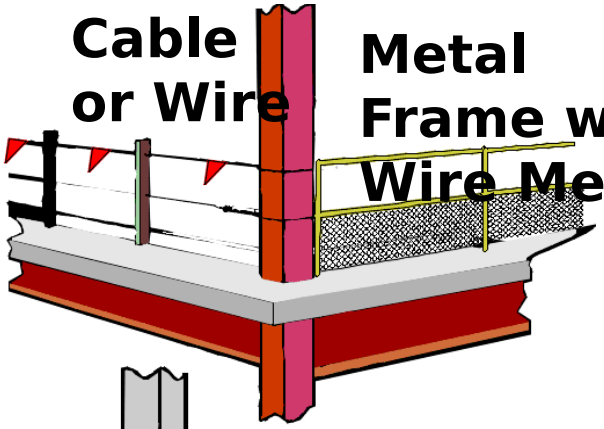
- **Guardrails can be made of many different**



Job Built

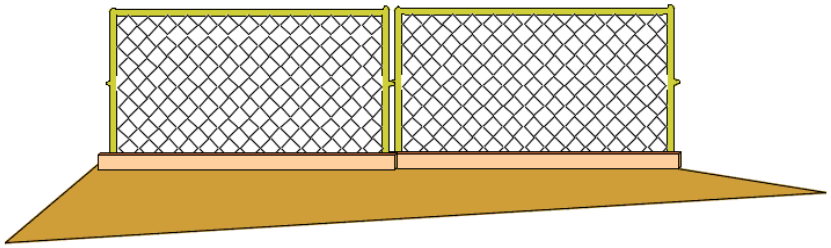


Prefab Metal Frame

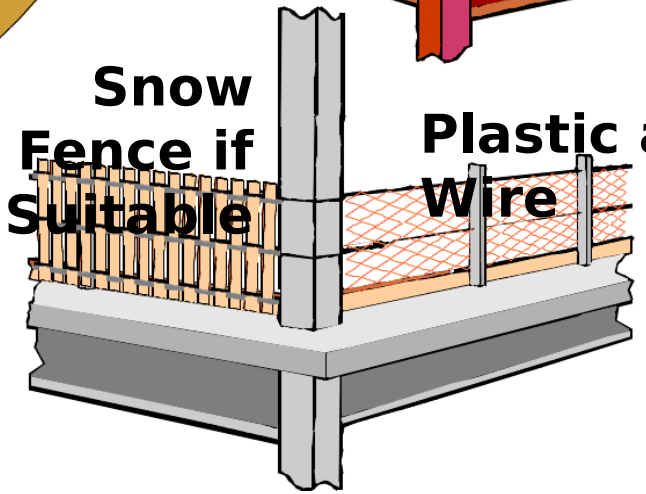


Cable or Wire

Metal Frame with Wire Mesh



Wire Mesh Filled



Snow Fence if Suitable

Plastic and Wire

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Job-Made Wood Guardrail Syste

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Manufactured Guardrail Systems

This is one type of available guardrails for use on flat roofs.

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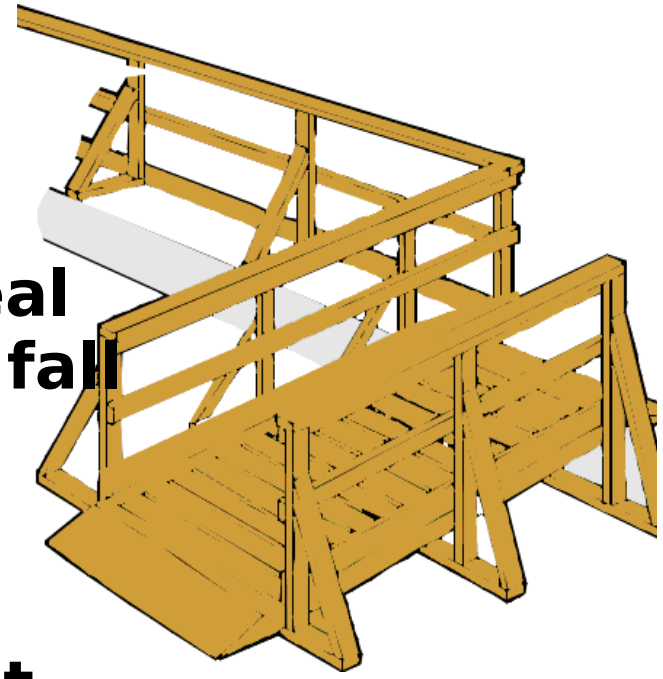
Advantages/Disadvantages

- **Advantages:**
  - **Low cost and easy to install**
  - **Well known purpose**
  - **Passive system - provides real barrier between worker and fall hazard**
- **Disadvantages:**
  - **May interfere with work**
  - **Easily removed and often not reinstalled**



Guardrails are a good choice for fall prevention. They are part of 100% fall protection in most work environments.

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Hole Covers

- **Cover all floor, ceiling, or working surface holes that are larger than 2 inches.**
  - **In roadways, must support twice maximum axle load.**
  - **All others must support twice the weight of employees, equipment, and materials that might be imposed at one time.**
  - **Secure from displacement by wind, equipment, or workers.**
  - **Color coded or marked "hole" or "cover."**

Cover holes as soon as they are created.

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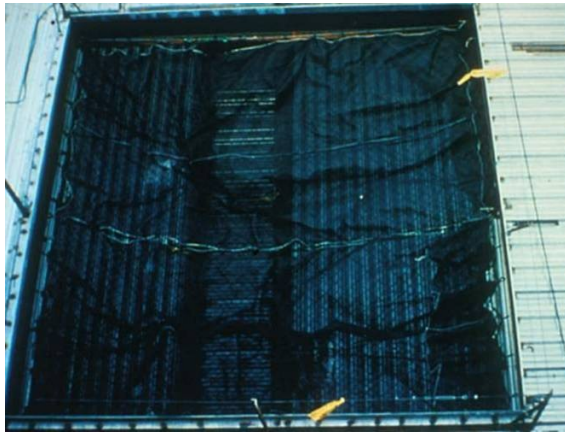
Preventing Falls Through Roof Holes

Skylights or larger deck holes can be covered, surrounded by barriers or have nets put underneath.



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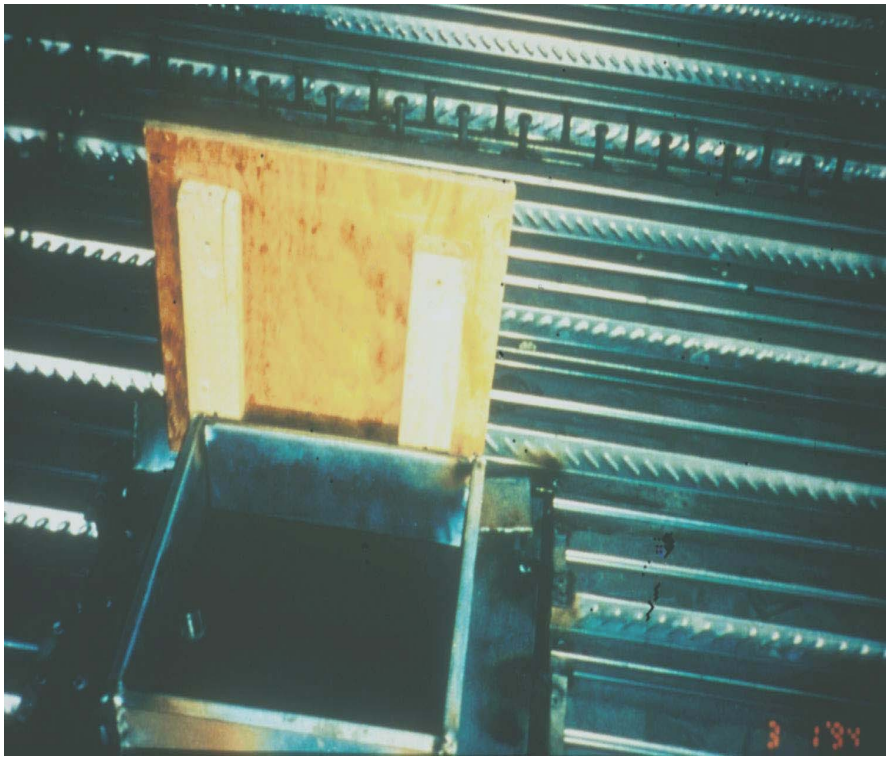
Floor/Deck Hole Covers



Secured? Clearly Marked?
Capable of supporting 2X weight imposed?

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Holes in Deck During Repair

Protection must be provided as soon as hole is created:

- **Cover over**
- **Guardrail around**
- **Net under**
- **Tie workers back**

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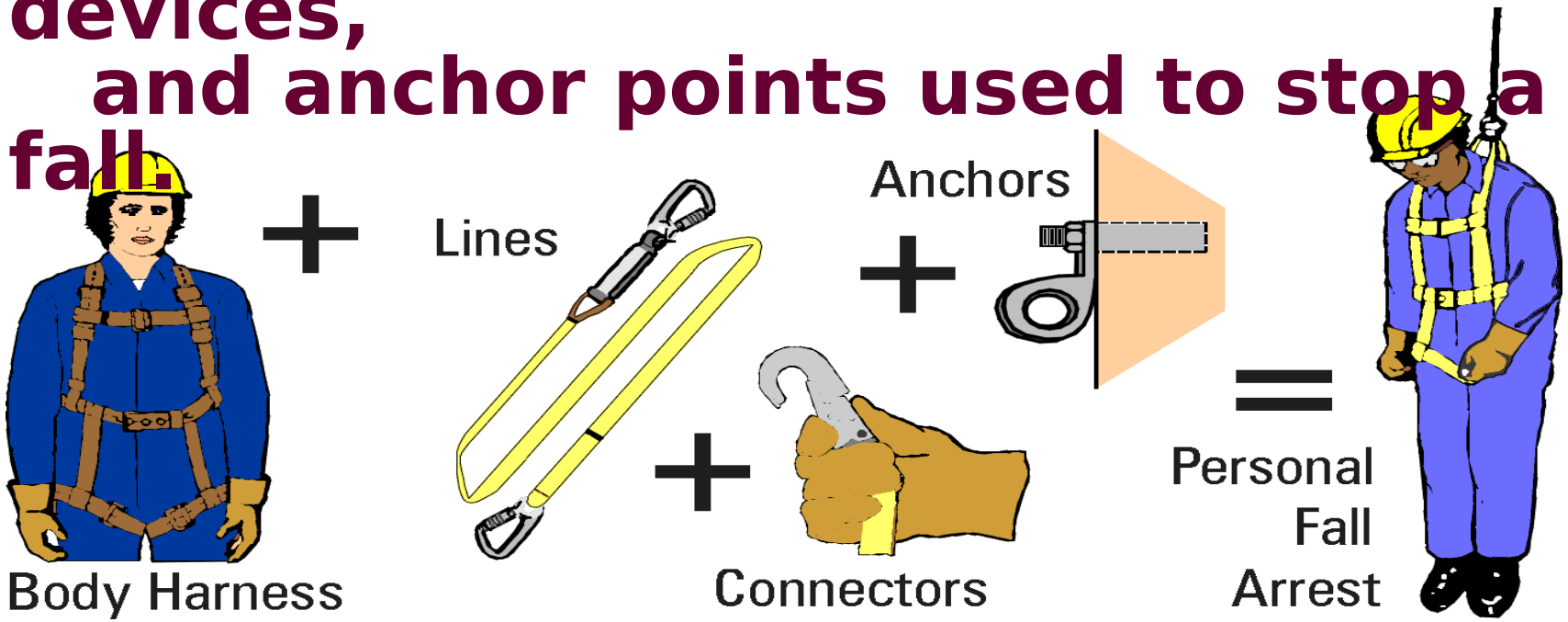
Personal Fall Arrest Systems (PFAS)

- **Body harness, lines, connecting devices, and anchor points used to stop a fall.**



If one of these parts fails, the system fails.

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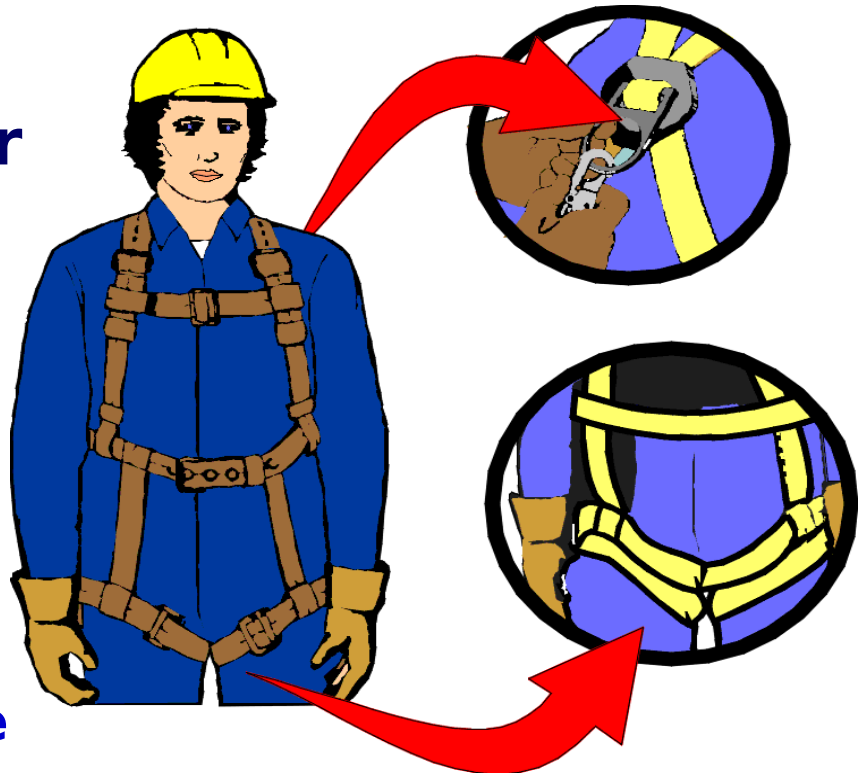
Body Harness

- **Most body harnesses have these parts:**
  - **Shoulder straps**
  - **Shoulder strap retainer**
  - **Dee-ring**
  - **Waist strap**
  - **Thigh straps**
  - **Sub-pelvic support**
  - **Adjustment buckles**

Some designs may not have waist straps or sub-pelvic supports.



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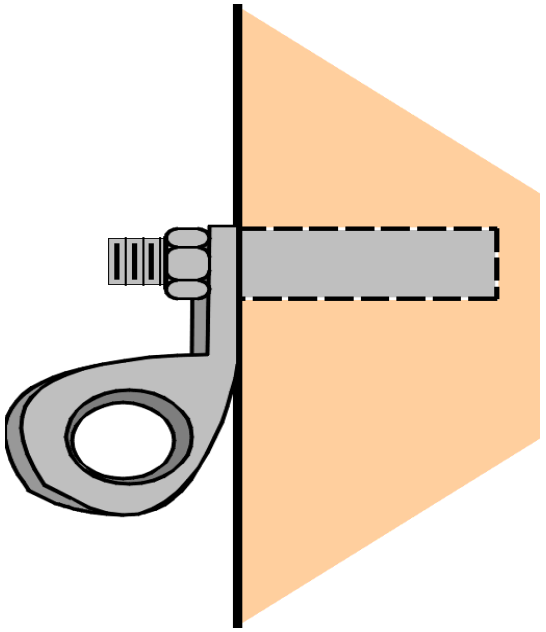
Anchorage

- **OSHA has specific requirements:**
  - **Capable of supporting at least 5,000 pounds per attached employee *or* used as part of an engineer-designed system that maintains a safety factor of at least ‘2’.**
  - **Independent of any anchorage being used to support or suspend platforms.**



Personal fall arrest must never be attached to guardrails.

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PFAS Devices

Roof bracket

Rope grab on a lanyard with deceleration device

PFAS Devices

Self-Retracting Lifeline

- **Limits fall to 2 feet or less**
- **Must be attached directly to “D” ring on harness**
  - **Shock absorber may prevent lock up, or lead to ratchet effect.**
- **Line must be protected from damage over edges.**
- **Install and inspect in accordance with manufacturer; some will work horizontally,while some will not.**

PFAS Devices

Horizontal Life Lines

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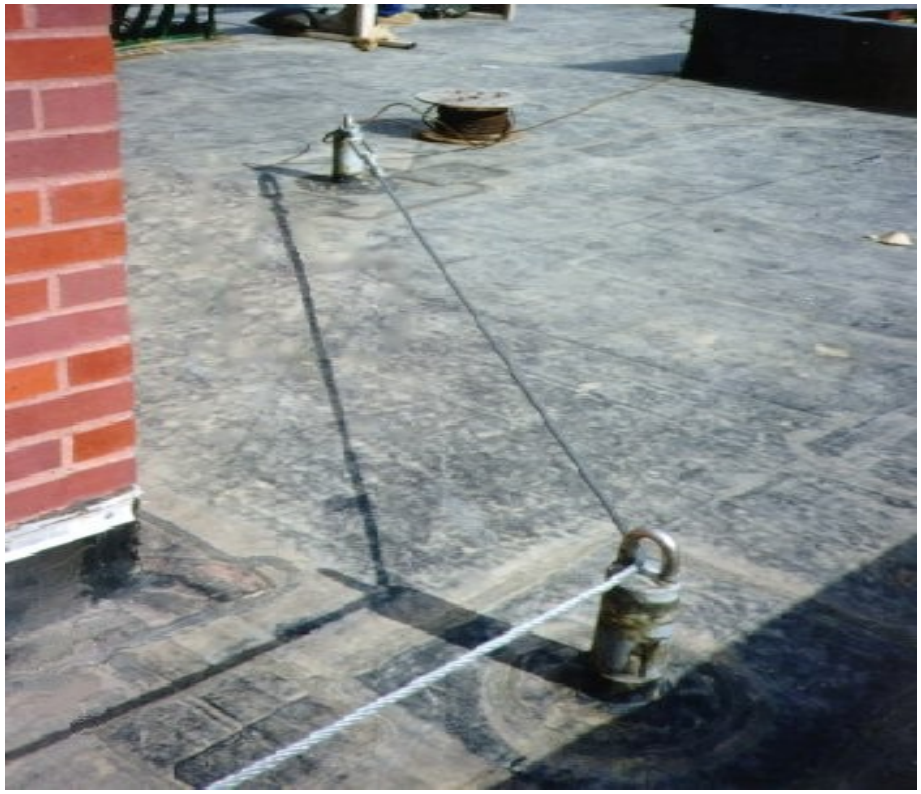
PFAS Devices



Using a horizontal line as a tieback point

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PFAS Devices

Permanently installed roof maintenance fall protection.

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Using Personal Fall Arrest Systems

- **PFAS is an *active means* of fall protection.**
- **You must understand its proper use, application and limitations.**
- **If you are not properly “tied off” you will not be protected in the event of a fall.**
- **Apply PFAS as if you expect to fall – what will happen?**

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Making the PFAS Work for You

- ***Think before you tie! Will you stop?***
  - **What are you attached to?**
- **Making the connection**
  - **Make sure the lock on your hook is working.**
  - **Do not wrap around & hook back to lanyard.**
  - **Do not shorten the lanyard with a knot.**
  - **If possible, always hook up at ‘D’ ring height.**
  - **Do not hook lanyards together.**

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Making PFAS Work for You

- **OSHA Requirements for PFAS**
  - **Maximum "Free Fall" is to be *6 feet*.**
  - **Maximum force on your body when you come to a stop is *1800 pounds*.**
    - **Actual force depends on your weight & fall distance.**
    - **The shorter the fall the better.**
  - **Maximum deceleration distance is *3.5 feet.***
    - **Stopping distance after your lanyard becomes tight & the shock absorber begins to stretch.**

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Making the PFAS Work for You

- **Other variables – what happens as you fall?**
  - **Clearance distance – will you hit anything?**
    - **6 Ft. + 3.5 Ft. + 5 Ft. + stretch + 'D' ring height.**
  - **Swing fall hazard - will you be a pendulum?**
    - **Are you anchored directly overhead?**
  - **RESCUE!**
    - **If PFAS is your protection, then your employer's fall protection program must have a way to get you down.**

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PFAS Advantages & Disadvantages

- **Advantages:**
  - **Effective anywhere there is an anchorage.**
  - **Requires little time to employ; is adaptable.**
- **Disadvantages:**
  - **The equipment is subject to wear and damage; it must be inspected and maintained.**
  - **Work habits may have to be changed to accommodate its use.**
  - **Requires considerable training.**

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Safety Nets

- **Hung beneath the work area to catch workers or debris.**
  - **Installed as close as possible under the walking/working surface - never more than 30 feet below working levels.**
  - **Must extend 8 to 13 feet outward from outermost projection of work surface.**
  - **Must be inspected weekly.**
  - **Any debris that falls into the net must be removed before the end of the work shift.**
  - **Not commonly used in roofing.**

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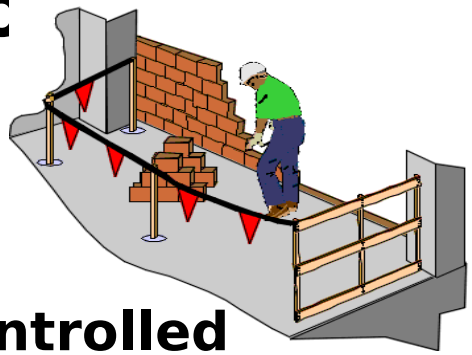
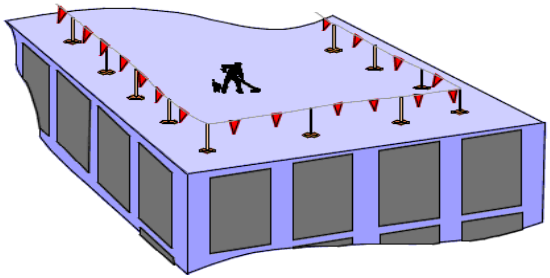
Alternative Measures to Conventional Fall Protection

- **Subpart M allows alternatives for pre-cast concrete, leading edge work, overhead bricklaying, roofing and residential construction**



Controlled Access Zone



Warning Line System

Safety Monitoring System

The employer must prove conventional protection is infeasible or would cause a greater hazard and then develop a written fall protection plan – except in roofing, overhand bricklaying, and residential construction.

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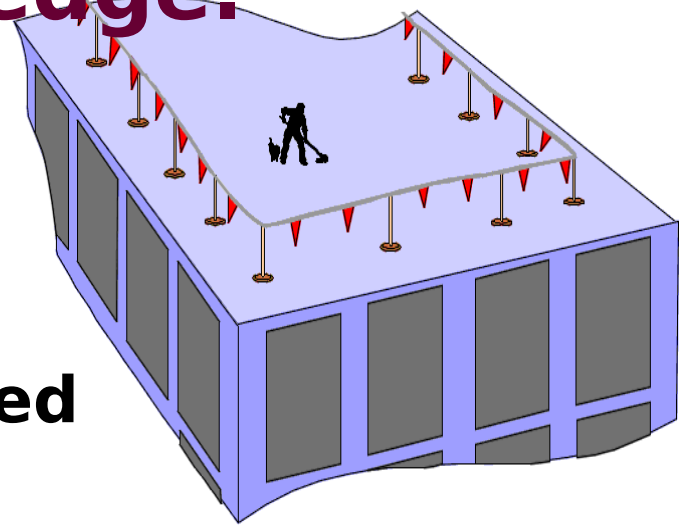
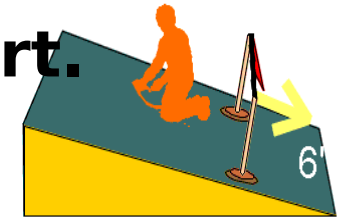
Warning Lines

- **Barrier to warn workers approaching the edge.**



- **Defines area where roofing work can be done without conventional fall protection.**
- **Consists of ropes, wires, or chains, and stanchions erected around all sides of the roof.**
- **High-visibility flags not more than 6’ apart.**
- **Line is no more than 39” and no less than 34” from surface.**



Used only on low-sloped roofs.

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Warning Lines

- **Must be functional, not just visual.**
  - **Minimum 500 pounds tensile strength**
  - **Stanchions resist 16 lbs. tipping force**
  - **Secured at each stanchion so line doesn't pull through when contacted.**
  - **Install line and stanchions according to the manufacturer.**
  - **Adjust as necessary – lines may stretch as the day gets hotter.**

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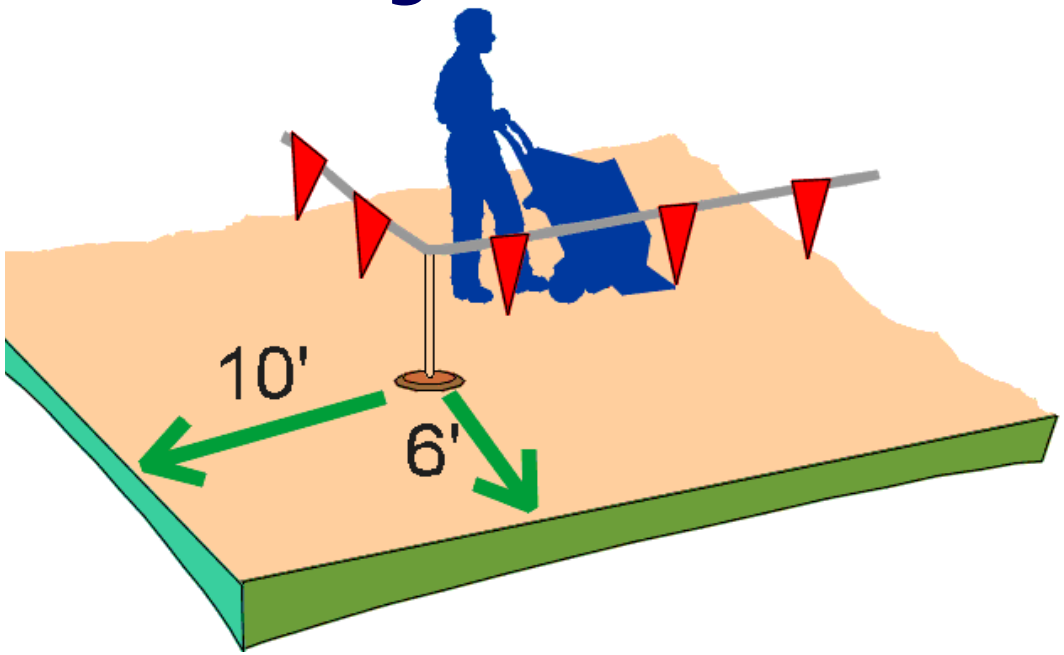
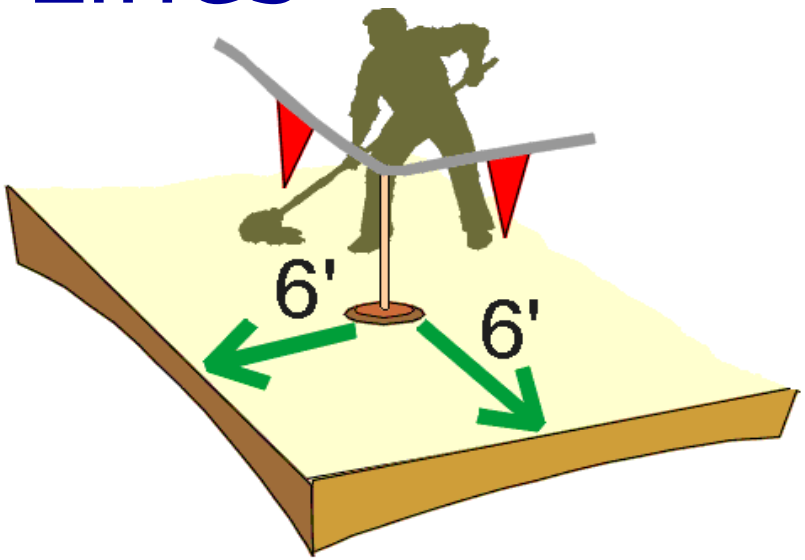
Warning Lines

Manual work: **place line >6' from edge.**





Mechanical work: **place line >6' from edge parallel to equipment direction and >10' from edge perpendicular to equipment direction. Workers *cannot* operate mechanical equipment outside of warning line without use of conventional fall protection.**

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Safety Monitoring System

- **Use of a *Competent Person* to warn workers near edges.**
  - **Permitted only for precast concrete erection, leading edge work, roofing, and residential construction.**
  - **Competent Person must be:**
    - **competent in recognizing fall hazards**
    - **capable of warning workers**
    - **operating on same surface**
    - **close enough to communicate orally**

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Safety Monitoring System$_2$

- **Competent Person must not be performing other work that will distract from watching the workers.**
- **Cannot be used <u>alone</u> on:**
  - **Roofs greater than 50 feet wide**
  - **Roofs sloped greater than 4-in-12**
  - **Metal or tile roofs sloped greater than 8-in-12**

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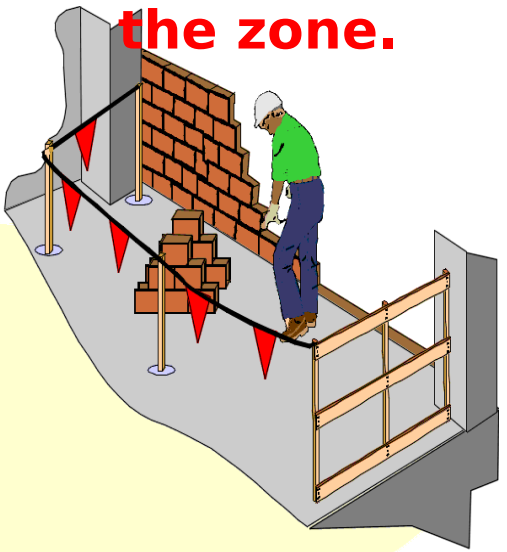
Controlled Access Zone

- **Area where work can go on without fall protection.**
  - **Limits access to authorized workers**
  - **Defined by control lines, barriers, markers**
  - **Control lines are rope, wire, or tape**
  - **Must be flagged at intervals of 6’ or less**

No protection for workers in the zone.



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Controlled Access Zone

- **Lines must be between 39” and 45” high.**
- **Must sustain stress not less than 200 pounds.**
- **Must extend length of unprotected edge and be parallel with it.**
- **Each end must connect with guardrail system or wall.**
- **Erected not less than 6’ and not more than 60’ from the edge.**

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Controlled Access Zone Size

- **Control line distances determined by w**

Type of Work	Control Line Distance	
	Minimum	Maximum
Erection of Precast Concrete	6 feet	60 feet
Leading Edge Work	6 feet	25 feet
Overhand Brick Laying	10 feet	15 feet

CAZ not permitted for roofing work.

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Fall Protection Options for Low-Slope Roofs

- **Definition: Slope less than 4:12**
- **Guardrail, safety net, or PFAS required at 6 feet, *or, a combination of:***
  - **Warning line and guardrail**
  - **Warning line and safety net**
  - **Warning line and PFAS**
  - **Warning line and safety monitor**
- **Safety monitor can be used alone on low-slope roofs less than 50 feet wide**

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Low-Slope Roofs – Perimeter Guarding

Wall-Mounted Guardrail Systems

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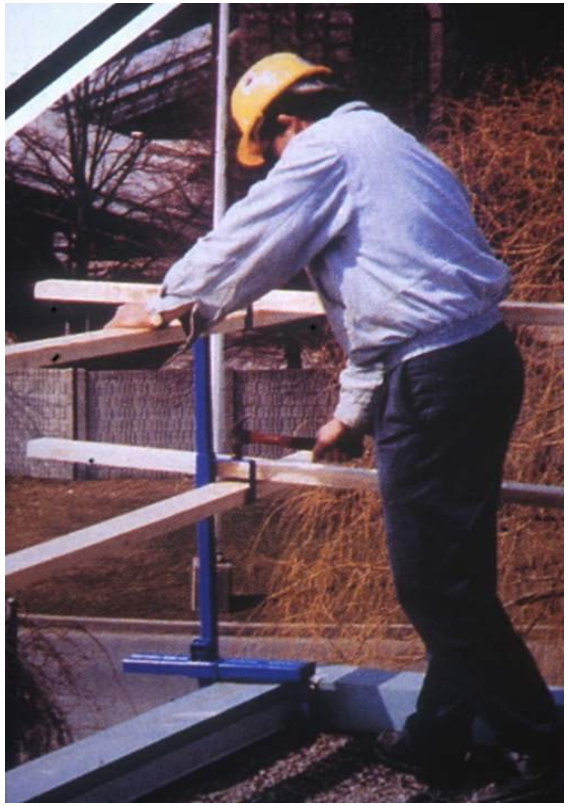
Low-Slope Roofs – Perimeter Guarding



Extending the parapet wal

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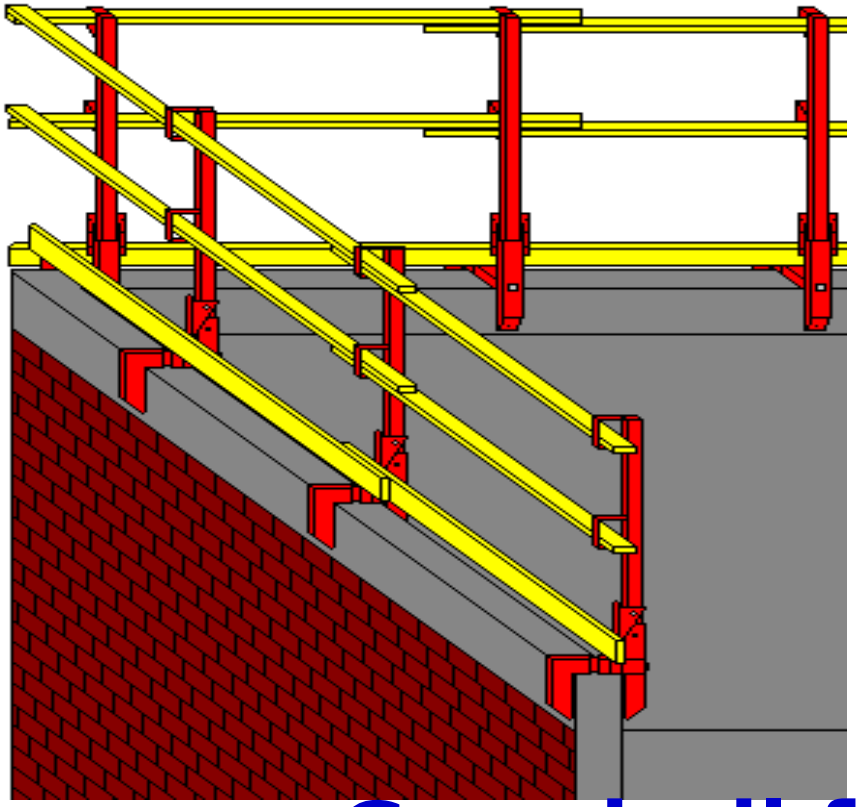
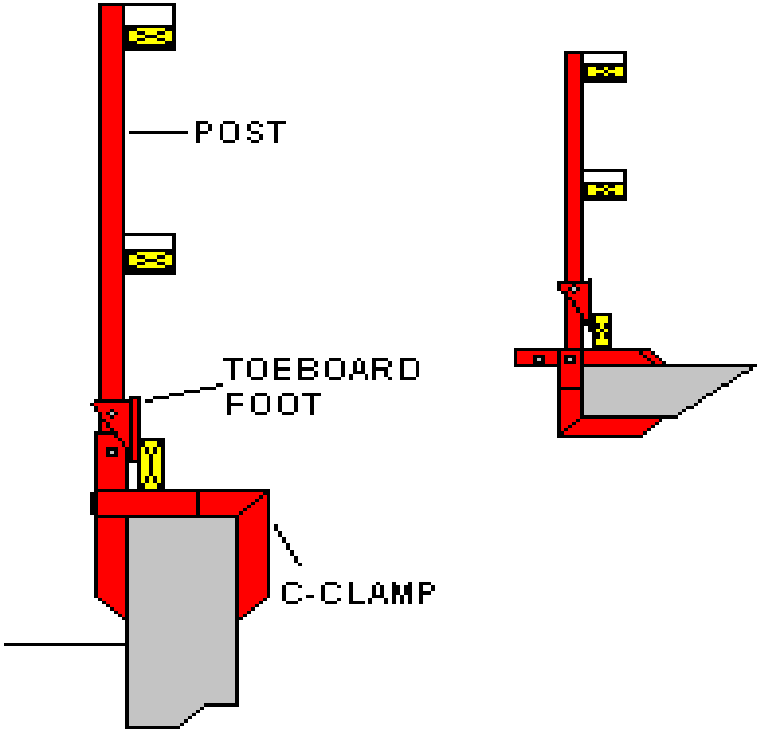
Low-Slope Roofs – Perimeter Guarding





Guardrail for parapet walls

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Low-Slope Roofs – Perimeter Guarding

Parapet Walls less than 39”

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Low-Slope Roofs - Perimeter Guarding

Providing protection

Ignoring the hazard

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Low-Slope Roofs - PFAS

This is one manufacturer's design of a moveable anchor for restraint or fall arrest for 2 workers.

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Low- Slope Roofs

When does "Fall Hazard Awareness" begin?

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Low-Slope Roofs

Fall Hazard Awareness?

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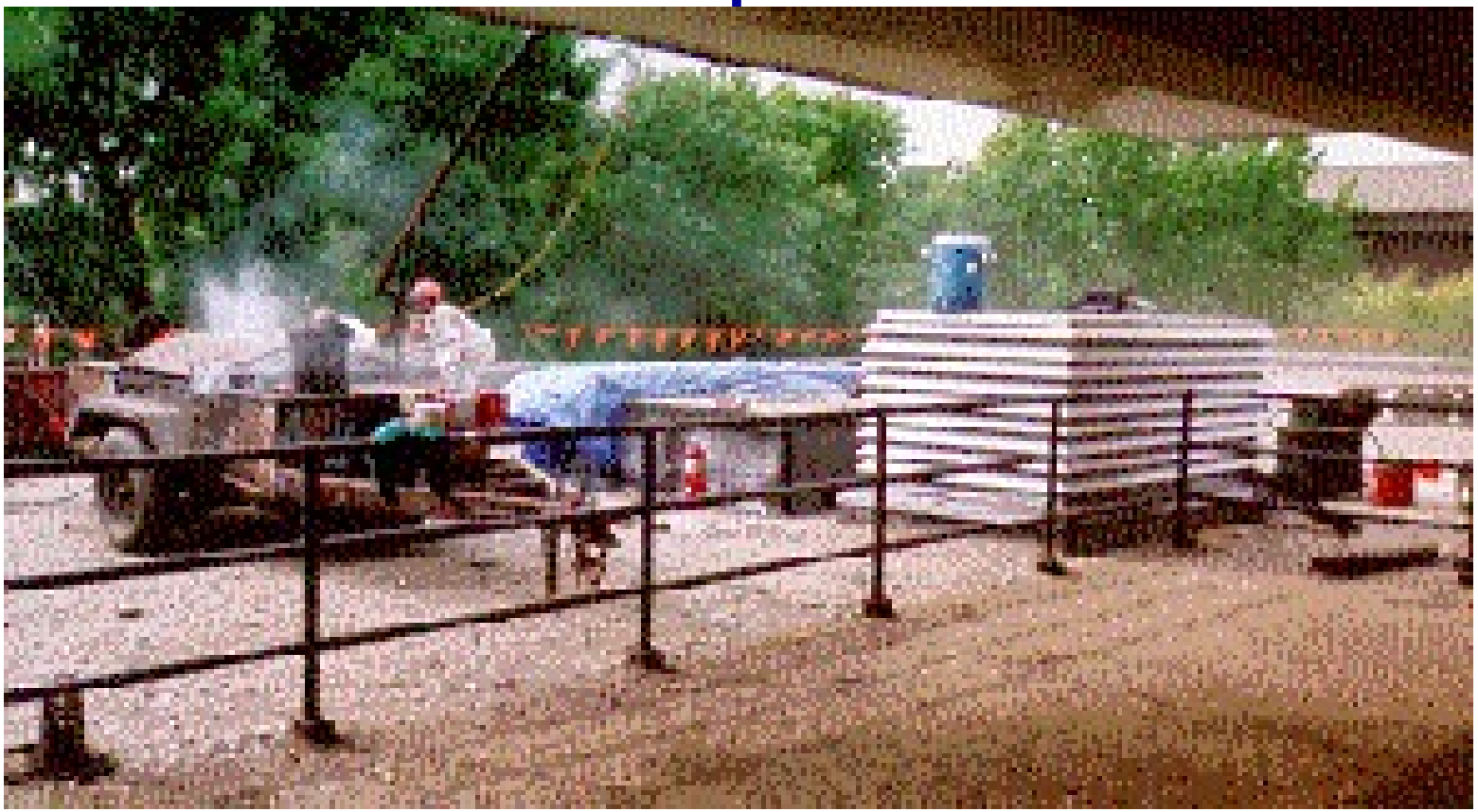
Low-Slope Roofs



What is wrong with this picture????

Low-Slope Roofs

Barrier tape *is not* an adequate warning line as it provides no resistance to a person

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Fall Protection Options for Steep Roofs

- **Defined as greater than *4:12 pitch***
- **OSHA Subpart M requires conventional fall protection at 6 feet**
- **Exception only for residential construction**

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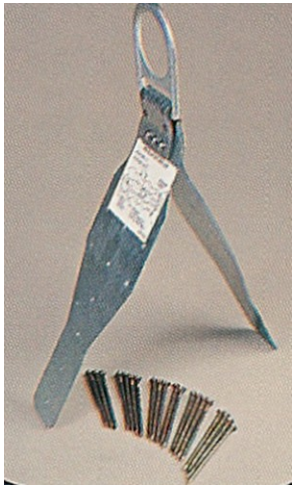
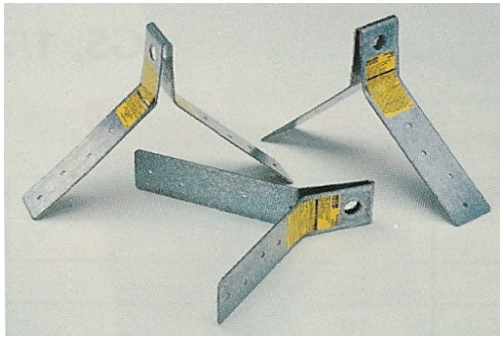
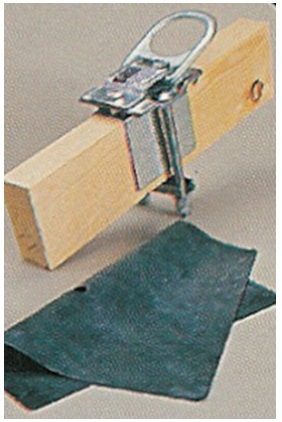
Steep Roofs - PFAS

Anchorages







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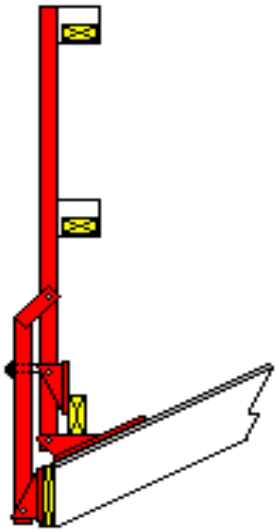
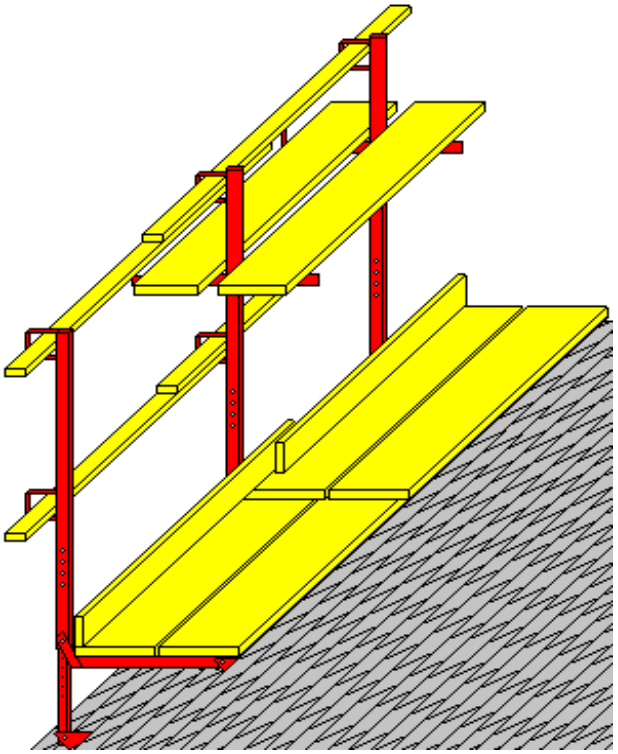
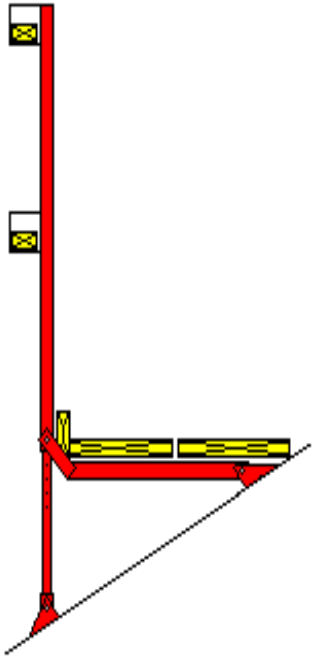
Steep Roofs – Guardrail Systems

Protection Before You Start



Facia Rail





Platform Rail

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Steep Roofs – Guardrail Systems

Another version - Guardrail installed after roof edge is finished.

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Steep Roofs – Guardrail Systems

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Steep Roofs – Guardrail Systems

This type will work on sloped or flat surfaces or connect to a scaffold coupling pin.

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Steep Roofs – Guardrail Systems

This kind mounts on a pivoted bracket and places the guard rail past the gutter line

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Steep Roofs - Applying Standing Seam Metal

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Steep Roofs - Applying Standing Seam Metal$_2$

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- **Six foot fall protection rule is modified by STD 3-0.1A, allowing alternative procedures for certain "residential construction" activities, including roofing work.**

- **Residential means same methods and materials as single family home construction – wood frame construction.**

  – **Includes 'discrete parts" of commercial buildings, such as shingled entranceways.**

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Residential Construction

Does this structure meet the "residential" definition?

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Residential Construction – Roofing Activities

- **Alternative fall protection procedures can be used for residential roofing activities only if:**
  - **The roof slope is < 8:12, and**
  - **The fall distance, measured from the eave to the ground level, is 25 feet or less.**

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Residential Construction – Roofing Activities

- **General Requirements:**
  - **Workers must be specially trained in the fall protection measures to be used.**
  - **Roof must be inspected for roof hazards and workers must wear appropriate footwear to avoid slipping.**
  - **Work must be suspended for bad weather.**
  - **Holes or openings must be covered or guarded, and damaged areas of roof deck must be repaired ASAP.**

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Residential Construction – Roofing Activities

- **General Requirements:**
  - **Ladders and scaffolds must be used in accordance with Subparts X & L.**
  - **Workers cannot go up or down slope within 6 feet of the rake edge.**
  - **Supplies and materials cannot be stored within 6 feet of the rake edge or 3 feet where tile systems are being installed.**
  - **The area must be cleared of impalement hazards.**

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Fall Protection Options for Residential Construction - Roofing

- **Safety Monitors and Slide Guards**
  - **Slopes up to 4:12 (any roof type) – safety monitor or slide guards**
  - **Slopes 4:12 to 8:12 (except tile or metal) – slide guards required**
  - **Slopes ≤ to 8:12 (tile or metal roofs) – safety monitor alone can be used**
  - **Slopes > 8:12 – no alternatives to conventional fall protection**
  - **Eave height > 25 feet – no alternatives**

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Slide Guards

- **Must be made of 2” x 6” stock with face near 90^{0} to deck.**
- **For 6:12 or less - continuous row at eave, maximum 3 rows up.**
- **Roof Jacks or other support must be nailed to take someone sliding into it.**
- **6:12 to 8:12 – placed at eave and every 8 feet placed as work continues up slope;**

  don’t have to be at 90 degrees to deck.
- **Remove while coming down; eave guards last.**

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Slide Guards & Roofing Brackets

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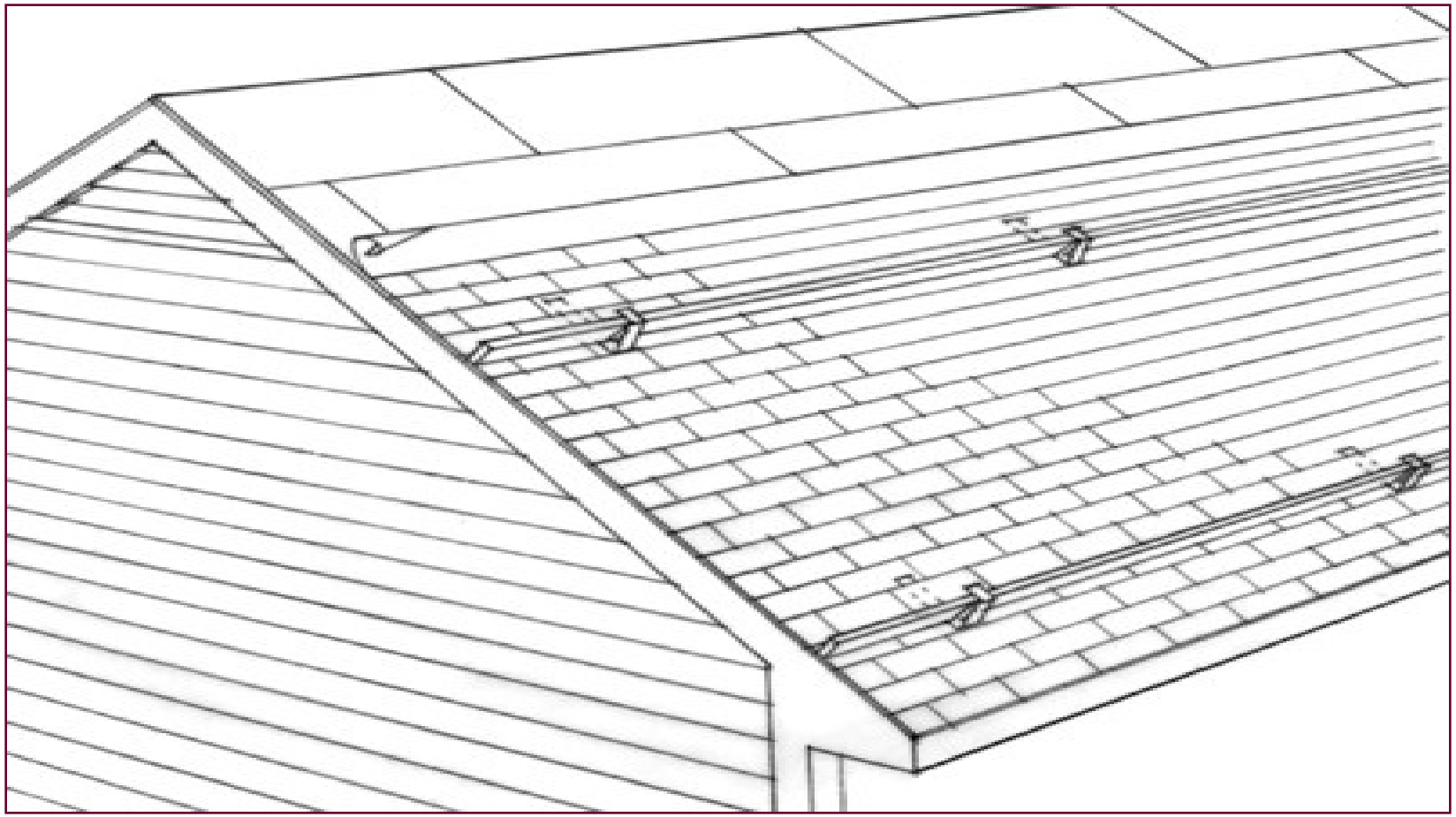
Slide Guards



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Residential Construction

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Evaluating the Roofing Job for Fall Hazards

- **Consider this:**
  - **Is the roof low-sloped (flat) or steep?**
  - **What is the best means of access?**
    - **Ladders? Scaffold Stair Tower? Already available inside or outside ladder or stairway?**
    - **What fall hazards will access create?**

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Evaluating the *Low-Slope* Roofing Job for Fall Hazards

- **Consider this:**
  - **Is there a parapet wall or other perimeter high enough to be adequate protection?**
    - **If not, can guardrails be installed, and what kind?**
  - **Are there skylights or other deck openings?**
    - **Will covers, guardrails or nets be used?**
  - **Are there areas to be replaced which will create temporary holes?**
    - **What protection will be used during the repair process?**

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Evaluating the *Low-Slope* Roofing Job for Fall Hazards

- **Consider this:**
  - **Will a warning line and safety monitor system be adequate?**
  - **Who is to be designated safety monitor?**
    - **Are they adequately trained and experienced?**
  - **What protection will be needed for access and hoist/material-receiving areas?**
    - **Can a tie-back system be established?**
  - **Are all potential workers trained in the recognition and control of fall hazards for this type of roof?**

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Evaluating the *Steep* Roofing Job for Fall Hazards

- **Consider this:**
  - **What is the slope and shape of the roof?**
  - **What kind of material surface does it have?**
    - **Slate, asphalt shingle, tile, metal?**
  - **How high are the eaves?**
  - **What means of access will be used?**
    - **Ladders, Ladder jacks, Pump jacks, Scissor lift, or Frame scaffold?**

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Evaluating the *Steep* Roofing Job for Fall Hazards

- **Consider this:**
  - **Does this roof meet the criteria for STD 3-0.1A?**
    - **Materials and methods similar to single family home construction?**
    - **Eaves less than 25 feet; total height less than 3.5 stories or 48 feet?**
  - **Are all potential workers trained in the recognition and control of fall hazards for this type of roofing?**

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Fall Protection
(29 CFR 1926.500 - .503)

Common OSHA Citations:

- **.501(b)(1): Unprotected sides & edges – fall protection**
- **.503(a)(1): Fall hazards training program**
- **.501(b)(13): Fall protection – residential**
- **.501(b)(10): Fall protection – low-sloped roofs**
- **.501(b)(4)(i): Fall protection – holes & skylights**

How can the hazards addressed by these Standards best be corrected, controlled, or eliminated?